

**Knowledge and Attitudes of the Role of Artificial Intelligence in Healthcare among
Undergraduate Nursing Students in the Northeast of Pakistan:
A Descriptive Cross-Sectional Study**

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ABSTRACT

Background: Artificial intelligence (AI) is progressively developing as a breakthrough in healthcare provision, improving clinical decision-making, patient safety, and efficiency. Nursing students must be sufficiently equipped to comprehend and exploit AI technologies as future healthcare specialists. Nevertheless, there is a lack of local data regarding the knowledge of the nursing students and their attitude to AI in healthcare in Pakistan.

Objective: This research evaluated the knowledge and attitude of undergraduate nursing students about artificial intelligence (AI) in healthcare in colleges of Northeast of Pakistan.

Methods: An in-depth survey was used to conduct a descriptive cross-sectional study among undergraduate Generic Bachelor of Science in Nursing (BScN) students of 11 nursing colleges located in Mardan Northeast of Pakistan over a period of four weeks. The method of sampling was the non-probability convenience sampling method. The sample size was determined using 95 percent of the confidence of a 5 percent margin of error in Open Epi. The participants (n=310) have been used to collect data using a structured and validated 2-rule questionnaire which included knowledge (10 questions) and attitude (10 questions) towards artificial intelligence in health care. The data analysis was carried out using descriptive analysis of frequencies, means, and standard deviations.

Results: Nursing students exhibit substantial knowledge regarding the issue of artificial intelligence. (mean knowledge score 4.02 ± 0.58). Most of the respondents agreed that AI had some beneficial use in the healthcare industry and could improve nursing practice and as such should feature in nursing learning. The overall attitude toward artificial intelligence was good as the mean score of the attitude was 3.72 ± 0.48 . The majority of the students viewed AI as useful in terms of patients and healthcare progress. Nevertheless, the problems concerning ethical concerns, privacy, legal duty, and job substitution were also communicated.

Conclusion: Undergraduates nursing students at Mardan, Northeast of Pakistan possess favorable

experiences and understand the artificially intelligent healthcare knowledge comprehensively. Despite positive perceptions, current challenges suggest that systematic education, ethics counseling, and curriculum alignment regarding AI that will equip future nurses with suitable approaches to experienced artificial intelligence, which is safe and effective.

Keywords: Knowledge, Artificial Intelligence, Attitude, Nursing Students, Healthcare, Pakistan.

INTRODUCTION

Artificial intelligence (AI) is quickly revolutionizing the healthcare field, and it requires a proper comprehension of its place among upcoming healthcare practitioners, especially among undergraduate nursing students [1]. It is essential to assess the level of knowledge and the attitude of these students towards being able to successfully integrate into clinical practice and education [2,3]. The literature has constantly demonstrated that although nursing students tend to acknowledge the potential of AI, the gaps in their knowledge and diverse attitudes tend to be numerous to be met with through the effective development of the curriculum and proper use of AI technologies [4-7].

The introduction of AI to nursing education implies the evaluation of the knowledge of students regarding AI applications, its advantages, challenges, and ethical issues [7]. On the one hand, AI in the medical sector refers to a broad range of applications, such as improving the clinical decision-making process, streamlining hospital processes, and augmenting patient care and monitoring [8]. As an example, AI algorithms have the capacity to process large amounts of patient data and offer evidence-based suggestions, enhance personalized medicine by designing treatment plans to specific patients, and make an accurate diagnosis in such areas as radiology and pathology [9,10] and [11]. The optimization of logistics, the automation of administrative processes, and a better flow of patients and schedule are other examples of AI-based contributions to the hospital

management [12]. AI-powered wearable gadgets and virtual nursing assistants help tremendously in remote care and patient monitoring by continually tracking vital data and offering assistance [13]. Even though these advantages have been identified, a major percentage of nursing students have little awareness of particular AI applications and their principles [14,15]. Indicatively, a recent study carried out in Pakistan revealed that the undergraduate nursing students were not equally aware of AI and its impact on healthcare, which is why educational interventions tailored to this population should be provided. In another study conducted in western China, students were positive about generative AI, but their actual usage and their level of such knowledge demonstrated that the curriculum should be optimized [16]. Such lack of knowledge is possible because of insufficient exposure to the concept of AI in their courses and a general unawareness regarding its widespread use in healthcare systems of the modern era [17,18].

The perception of AI in nursing students is multiple, as it may tend to be both positive and negative [19,20]. A large number of students admit that AI has the ability to enhance patient outcomes, make better decisions, and simplify work processes [21,17]. As an illustration, nursing students in Saudi Arabia tended to be positive and willing to use AI technology, and they understood that the technology had the potential to revolutionize medical practice [18]. Likewise, the Turkish research found that nursing students had a positive attitude to AI and saw its potential in future practice [9]. Such optimism is typically fueled by the fact that AI may result in the more efficient and effective care of patients [10].

Nevertheless, this interest is commonly restrained by such factors as consideration of ethical aspects, job loss, and must-have training [11]. Students report that they are afraid of the possibility of AI taking over human jobs in nursing, ethical issues related to patient privacy and data security, and the need to acquire additional skills in digital literacy to adjust to high-technology healthcare settings [14]. An example of a study conducted among nursing students in Jordan examined the relationship between AI ethical awareness, attitudes, anxiety, and the intention to use AI technology,

which showed that ethical considerations played an important role in their views [21]. In addition to that, the psychological consequences of AI implementation, such as possible distress and self-efficacy issues, were observed among nursing students [20].

To overcome these obstacles, curricula should be structured in a way to increase the AI literacy of nursing students and develop positive attitudes [15]. This will include the integration of AI-specific material into the nursing curriculum, practical preparation, and the promotion of the (collaborative) character of interaction between humans and AI instead of emphasizing its replacement [21]. Project-based learning is one of the interactive forms of learning, which could considerably increase the knowledge and confidence of students in the use of AI tools [20]. These methods assist students in overcoming the initial knowledge gaps, learning to cooperate, and stimulating the development of scientific research [15]. The experience of undergraduate nursing students working on an AI-based project is based on an emotional process. At the initial stage, they are disadvantaged by their lack of knowledge. During the adaptation stage, they are influenced by external factors that guide them toward self-fulfillment. At the completion of the project, they will have clear expectations and recommendations of their own. [16]. First, students might be confused, feel unfamiliar, and embarrassed because of the lack of knowledge and abilities, along with the excitement about challenging new things [17]. Through adaptation, cooperation ability, classroom participation satisfaction, and the central role played by the teachers and teaching assistants continue to improve in the growth of the individual [18]. Lastly, learners share their wants to continue learning deeper, provide feedback on how to improve their abilities, and provide recommendations on the way to teach them better [18].

Moreover, it is crucial to deal with possible biasness of the AI models and provide ethical governance. In healthcare, AI should be able to guarantee patient privacy, data safety, and transparent functionality to develop trust [19]. The idea of such a phenomenon as data provenance serves as the reminder of the fact that the quality and history of data utilized to train AI models

directly affects its accuracy and safety. To make AI systems accurate, reliable, and safe, rigorous validation procedures are commonly required that include testing algorithms on massive datasets to avoid biases and provide interpretable and useful systems [20]. To conclude, although undergraduate nursing students are likely to be aware of the increasing role of AI in the healthcare sector, their levels of knowledge and attitudes can be both high and low. It is evident that more comprehensive and interdisciplinary education techniques are required to not only increase AI literacy but deal with ethical issues, alleviate anxiety, and equip them to effectively apply AI into clinical practice in the future [21]

Aim

The purpose of the proposed study is to determine the extent of knowledge and perception regarding the use of artificial intelligence (AI) in nursing among undergraduate nursing students in Mardan, Northeast of Pakistan.

Objectives

1. To identify how much the undergraduate nursing students know about artificial intelligence and its application in healthcare.
2. To identify the influence of the undergraduate nursing students on the application of artificial intelligence in healthcare practice.
3. To ascertain the perceived benefits and concerns related to the introduction of artificial intelligence in the healthcare industry among nursing students.
4. To examine the relationship between the degree of knowledge and the attitude to use artificial intelligence in healthcare.
5. To formulate the influence of demographic and educational factors (year of study, prior experience with AI, and training) on the knowledge and attitudes of students.

6. To generate evidence likely to support the introduction of the study of artificial intelligence in the undergraduate nursing programs in Mardan, Northeast of Pakistan.

MATERIALS AND METHODS

Study Design and Setting

It is a descriptive cross-sectional study done on the nursing colleges in Mardan, Northeast of Pakistan, over a span of four weeks. The study was based on the aim of assessing the levels of knowledge and attitudes of the undergraduate nursing students concerning the use of artificial intelligence (AI) in healthcare.

Study Population

The research sample consisted of undergraduate students pursuing the Bachelor of Science in Nursing (BScN) at selected nursing institutions in Mardan, Northeast of Pakistan. The post-RN BScN and the diploma nursing students were omitted to ensure that the academics are exposed and trained in a uniform manner.

Sample Size and Sampling Method

The present study was a descriptive cross-sectional study to determine the degree of knowledge and attitude towards artificial intelligence (AI) in healthcare among undergraduate nursing students. Any information that was to be determined or computed to calculate the required sample size was done by the means of the open-source epidemiological statistics calculator known as OpenEpi version 3.

Cochran's sample size formula was used to compute the initial sample size of an infinite population (n_0) as follows:

$$n_0 = \frac{Z^2 p(1-p)}{d^2} = \frac{Z^2 pq}{d^2} = \frac{(1.96)^2 (0.5)(0.5)}{(0.05)^2} = 384$$

where: n_0 is the estimate sample size (infinite population), p represents the estimated proportion of the population possessing the characteristic of interest, while q is its complement ($q = 1 - p$). Since no prior estimate was available, we used $p = 0.5$ and $q = 0.5$, which provide the maximum variability and therefore the most conservative sample size. Z is the Z -score at 95% confidence level equal to 1.96, and d is the margin of error set to 0.05.

Since the study population, which is 1,567 undergraduate Generic BSN students in Mardan district is finite (total population $N = 1,567$), the finite population correction (FPC) formula was used to calculate the adjusted sample size (n):

$$n = \frac{n_0}{\left(1 + \frac{n_0 - 1}{N}\right)} = \frac{384}{\left(1 + \frac{384 - 1}{1,567}\right)} = 309$$

where: n is final adjusted estimate sample size and N is the total population size (1,567). Hence, 309 students were the minimum sample required.

In order to reduce non-response bias and missing questionnaires, all eligible and accessible undergraduate BSN students were contacted to take part. The number of students that answered the survey reached 310, which is sufficiently to justify the statistical sufficiency of the research.

Sampling Details

The non-probability convenience sampling technique was used based on practicality such as availability of the respondents, time factor and the research was exploratory.

Recruitment of Students

The sampling technique involved students who were selected in nursing colleges in Mardan, Northeast of Pakistan that provided administrative support to the research. The process of recruitment was organized with the help of the faculty coordinators and class representatives, who sent all eligible students the survey link using official academic communication tools, such as WhatsApp groups, institutional email lists, and academic forums.

Contexts of Participation

Participation was mainly through online medium (Google Forms), through which the students could use their own time to fill the questionnaire. Also, there was information exchange on the study in the classroom and laboratory time when the faculty briefly described the purpose and procedures without imposing pressure on students to take part.

Voluntary Participation

The involvement was voluntary. Detailed information on the study including objectives of the study, procedures and the possible benefits was given to the students. They had signed the informed consent electronically before they could gain access to the questionnaire. Students were promised that either way of involvement (or non-involvement) would not in any way interfere with their academic assessment. The management of self-selection bias involves selecting cases evenly: the proportion of male to female cases will be equal.

Although convenience sampling carries a risk of self-selection bias, several measures were employed to minimize this possibility. The offer to participate was sent to all eligible students without any regard to previous interest or knowledge on AI. There were several reminders to help the students who may have otherwise chosen not to take part in the study, which increased the sample representativeness. The fact that the participants are represented by various colleges in the

Mardan district makes the study less prone to bias and more reliable in the findings.

Eligibility Criteria

Only the students who are currently pursuing the Generic BSN program were eligible to get included. Students of post-RN and diploma nurses were not included to make sure that the exposure and training were similar in academics. Students who refused to take part or even filled out the questionnaires were also not included in final analysis.

The convenience sampling can reduce the level of generalizability, but in this case of studying the institution on an exploratory basis, it was considered suitable. The success of having a sample that is equal and slightly greater than the required size and the inclusion of students representing various institutions increases the representativeness and the validity of the study results.

Data Collection Tool

Data collection was done through the structured and standardized questionnaire, which was based on the already published and verified studies of knowledge and attitudes toward artificial intelligence in healthcare [9]. Little local contextual modifications were made to fit the local academic context without tampering with the original validity of the content. The original tools were obtained, and the authors were approached and allowed to use the tool.

The questionnaire was separated into two:

- Part I: Assessment of the application of artificial intelligence in healthcare (10 multiple choices)
- Part II: Attitude about artificial intelligence application in healthcare (10 multiple choices).

All the items were dedicated to the main topics, applications, benefits, and concerns of artificial

intelligence in health care facilities.

Data Collection Procedure

The questionnaire was created based on the survey translated into a questionnaire and posted online through the Google Forms platform and sent to the respondents through mobile applications. The participation had been done with informed consent that had been informed in the electronic form. The research was a voluntary one, and the respondents were free to abandon the research at any given time.

Ethical Considerations

The Institutional Review Board (IRB) approved of the study ethically. The participants were assured that their information, privacy, and anonymity were assured. They were informed that they were taking part in the research work voluntarily, and they could withdraw at any stage without any academic and personal consequences.

Statistical Analysis

The data were analyzed using SPSS version 26. All the variables were calculated to obtain the descriptive statistics. On the continuous variables (age, knowledge scores, attitude scores), we have computed mean, standard deviation (SD), median, interquartile range (IQR), minimum and maximum. Frequencies and percentages were used to present categorical variables (gender, year of study, college name). We checked the normal distribution of knowledge and attitude scores with the help of the Shapiro-Wilk test. The Shapiro-Wilk p-value of both scores were greater than 0.05, which proves a normal distribution and meets the conditions of parametric tests.

The correlation coefficient employed to analyze the relationship between attitude scores and total knowledge scores was Pearson correlation coefficient. Linearity and the assumption of approximate

normality were verified and met.

Mean knowledge and attitude scores between male and female students were compared using independent samples t-test.

The one-way ANOVA was applied to analyze the data concerning the difference in the mean scores of knowledge and the attitude among four academic years. The choice of this test was due to the availability of the independent variable (academic year) with more than two levels. We checked the assumptions of homogeneity of variances and normality prior to the execution of the test. The Shapiro-Wilk test was used to determine normality and gave non-significant ($p > 0.05$) values in all the year groups, which indicated normally distributed data. The homogeneity of variances was tested with the Levene, which did not have a significant value ($p > 0.05$), and it proved that there were similar variances in groups. In the instances of overall ANOVA significance, post-hoc pairwise comparisons to control Type I error were then done using Tukey Honestly Significant Difference (HSD) test. The attitude scores were predicted using simple linear regression analysis and knowledge as the predictor variable. Independent predictors of attitudinal scores were examined using multiple linear regression, with the covariates of the model being knowledge score, year of study, and gender. The enter method was used to input all the predictors at the same time. In the two regression analyses, the conditions of linearity, independence of residues, homoscedasticity and normality of residues were tested. These conditions were satisfactorily achieved. Correlation and regression coefficients confidence intervals (95%) were also reported to estimate the precision.

The p-value (p) statistically significant was determined to be less than 0.05 and all p-values were two-tailed.

RESULTS

Demographic Characteristics of the participants.

In this study, 310 undergraduate nursing students were involved in the study who were selected in

the nursing colleges of Mardan. The average age of the participants was 20.56 (SD = 1.47) years with ages of 18-28 years (Table 1).

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	17	5	1.6
	19	97	31.3
	20	53	17.1
	21	64	20.6
	22	72	23.2
	23	10	3.2
	24	6	1.9
	25	2	0.6
Gender	28	1	0.3
	Male	257	83
Year of Study	Female	53	17.1
	1st Year	25	8
	2nd Year	138	44
	3rd Year	100	31
College Name	4th Year	48	15
	Matonia College of Nursing	50	16
	Elizabeth Rani College of Nursing	46	15
	BKMC College of Nursing, Mardan	41	13.2
	Institute of Health Sciences	39	12.6
	Government College of Nursing, Mardan	32	10.3
	Oriental College of Nursing, Mardan	31	10.0
	Alfajar College of Nursing	27	8.7
	TPIHS	23	7.4
	Mardan Institute of Nursing	11	3.5
	Zia College of Nursing	7	2.3
Kingsway Institute	3	1.0	

Table 1. Demographic Characteristics (N=310)

When it comes to gender distribution, most of the respondents were men (82.9%), and 17.1% were women. Regarding the academic year, the majority of students were taking the second year (44.5%), the third year (32.3%), the fourth year (15.2%), and the first year (8.1%). Students who were undertaking the BSN program were invited to take part in the research. The Students Participate from these 11 different nursing colleges within the district of Mardan. Matonia College of Nursing (16.1%), Elizabeth Rani College of Nursing (14.8%), BKMC College of Nursing, Mardan (13.2%), Institute of Health Sciences (12.6%), and Government College of Nursing, Mardan (10.3%) made the highest percentage proportion of the students. The rest were participants

of the Oriental College of Nursing (10.0%), Alfajar College of Nursing (8.7%), TPIHS (7.4%), Mardan Institute of Nursing (3.5%), Zia College of Nursing (2.3%), and Kingsway Institute (1.0%). This sample is a wide representation of Mardan undergraduate nursing students.

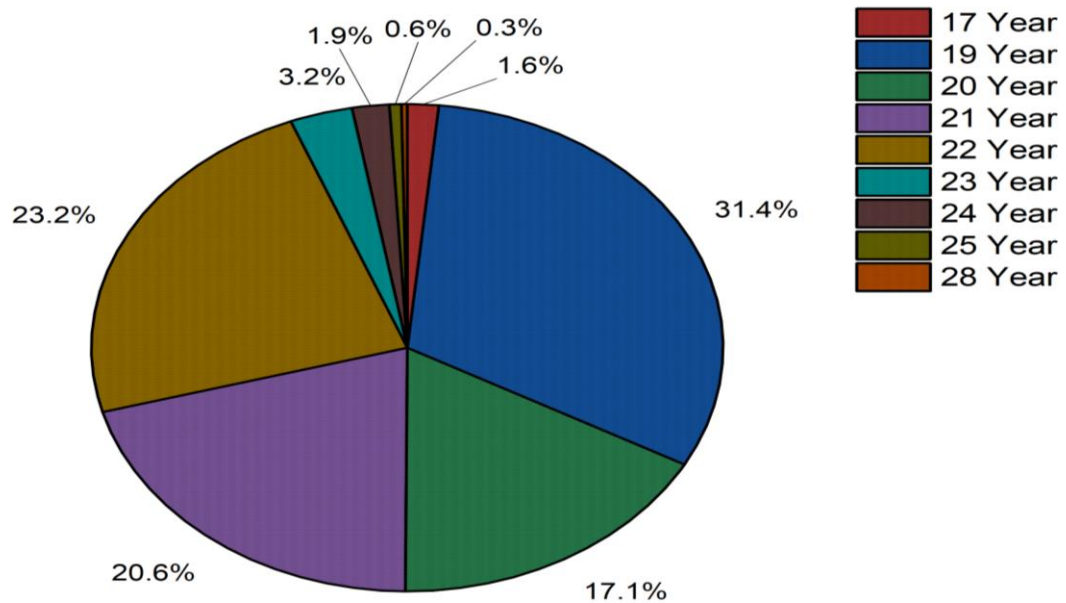


Figure 1. Age of nursing students (N=310)

The Figure 1 shows the age distribution of 310 nursing students of college going in Northeast Pakistan in the age range between 17 to 28. The number of students who fall within the range of 19 to 22 years is 92 percent. The highest percentage is 19 -year-olds (31.3) and 22-year-olds (23.2) and 20-year-olds (17.1). Ages of 23, 24, 17, 25 and 28 are included in smaller groups. The average age is 20.6 years which is normal among undergraduates in the area.

Figure 2 illustrates the enrollment of four years of BScN program. The highest number is of the second-year students (44.5%), third (32.3%), fourth (15.5%), and first-year students (8.1%). Sixty-seven percent of the respondents are in the second and third year, and this provides a balanced picture of the education levels.

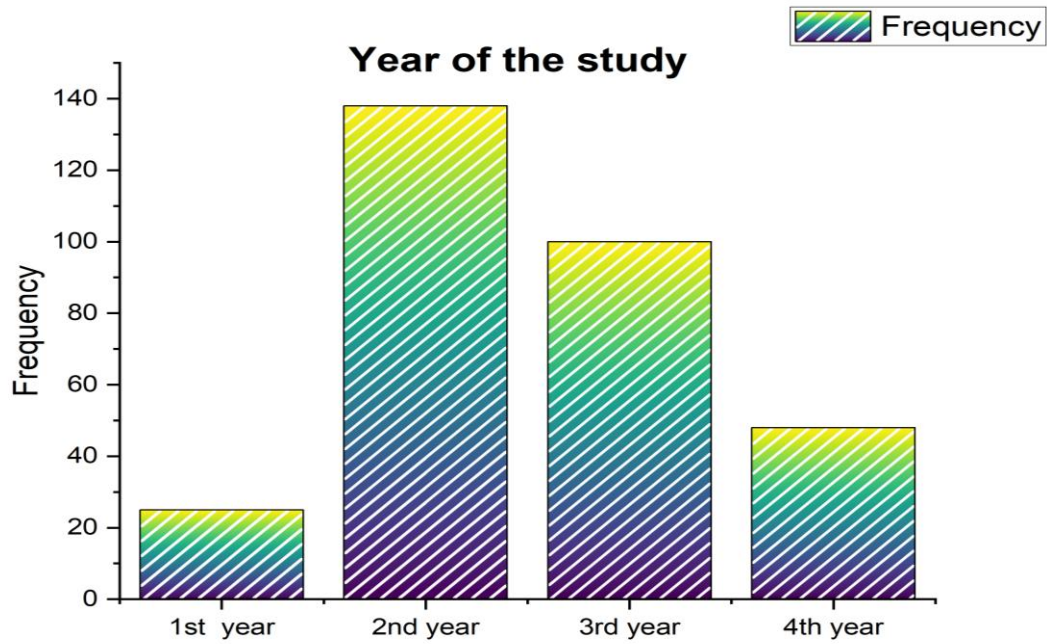


Figure 2. Students' year of study (N=310)

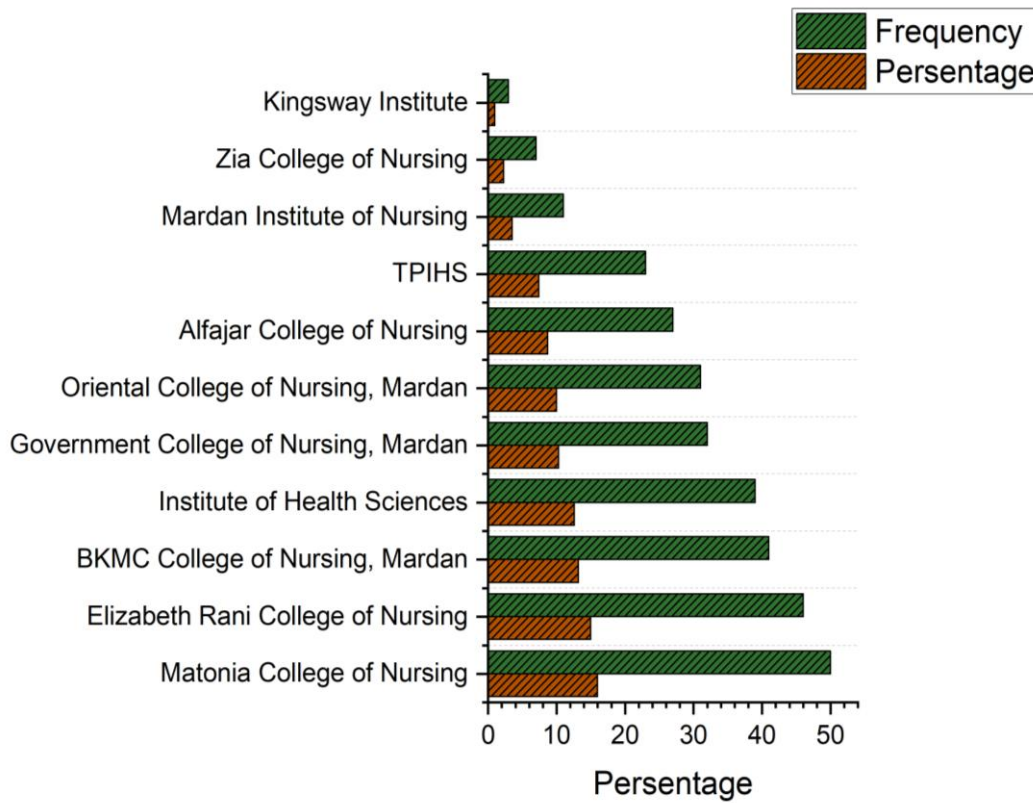


Figure 3. Names of Colleges (N=310)

The horizontal bar chart (Figure 3) enlists 11 colleges of nursing in Northeast Pakistan. The leading three ones are: Matonia College of Nursing (16.1%), Elizabeth Rani College of Nursing (14.8%), and BKMC College of Nursing, Mardan (13.2%), which constitute 44 percent of the sample. The others represented in these colleges are the Institute of Health Sciences, Government College of Nursing Mardan, Oriental College of Nursing, Alfajar College of Nursing, TPIHS, Mardan Institute of Nursing, Zia College of Nursing and the Kingsway Institute. The study has 11 colleges representation, and this increases the regional credibility of the study.

Artificial Intelligence knowledge in Undergraduate Nursing students

This paper evaluated the attentiveness of the undergraduate nursing students on the topic of artificial intelligence (AI) in healthcare. All in all, the level of knowledge was good as the mean score of knowledge was 4.02 (SD = 0.58).

Most of the participants acknowledged that artificial intelligence can be utilized in healthcare and nursing practice. The majority of the students correctly defined the important concepts in AI, including the distinction between machine learning and deep learning is, and what one of the useful applications of AI is in healthcare. Also, the legal and privacy issues connected with the use of AI in healthcare were documented by many respondents. Another significant percentage of students reported that AI is able to access the required information regarding patients and their medical history. Moreover, the majority of participants were in support of the addition of basic AI concepts in the nursing curriculum.

These results show that undergraduate nursing specialists have sufficient knowledge and experience of artificial intelligence in healthcare.

Knowledge Items	Strongly Agree n (%)	Agree n (%)	Neutral n (%)	Disagree n (%)	Strongly Disagree n (%)
Artificial intelligence is a useful application in healthcare	83 (26.77)	105 (33.87)	20 (6.45)	9 (2.90)	93 (30.00)
AI may raise legal issues in healthcare	36 (11.61)	114 (36.77)	44 (14.19)	21 (6.77)	95 (30.65)
There is a difference between machine learning and deep learning	75 (24.19)	97 (31.29)	38 (12.26)	9 (2.90)	91 (29.35)
Speech recognition or transcription is helpful in healthcare	71 (22.90)	116 (37.42)	20 (6.45)	9 (2.90)	94 (30.32)
Serious privacy issues can occur with the use of AI in healthcare	53 (17.10)	106 (34.19)	27 (8.71)	30 (9.68)	94 (30.32)
There are benefits of using artificial intelligence in nursing	90 (29.03)	94 (30.32)	16 (5.16)	16 (5.16)	94 (30.32)
AI could be useful in healthcare	80 (25.81)	100 (32.26)	23 (7.42)	12 (3.87)	95 (30.65)
AI can access patient medical history	60 (19.35)	108 (34.84)	29 (9.35)	18 (5.81)	95 (30.65)
AI improves accuracy in healthcare decision-making	78 (25.16)	101 (32.58)	24 (7.74)	12 (3.87)	95 (30.65)
AI will get all relevant information about a patient and medical history	53 (17.10)	106 (34.19)	27 (8.71)	30 (9.68)	94 (30.32)

Table 2. Question about knowledge ($N=310$).

The findings about respondents and their knowledge regarding the use of artificial intelligence (AI) in healthcare are provided in Table 2. Overall, the vast majority of participants agreed or strongly agreed with the statements and expressed a rather positive attitude towards the applications of artificial intelligence in healthcare and nursing. About 60 percent admitted that AI is helpful in the field of healthcare and enhances decision-making. Likewise, proportions saw the advantages of nursing and saw speech-recognition technology as beneficial. Numerous participants have also mentioned that AI can be used to improve and help them manage clinical information. However, around 30% strongly disagreed with several of the items. This implies that some respondents have limited knowledge or are uncertain about what machine learning and deep learning are, as well as how AI is applied in retrieving patient information.

The ethical and legal issues mentioned by many respondents were privacy issues and the legal consequences of using AI in healthcare. Overall, the awareness of AI among the participants is

moderate to good, yet additional education and training are necessary to enhance the growth of knowledge and awareness among healthcare providers.

Artificial Intelligence attitude in Undergraduate Nursing students

The overall perception of the nursing students towards artificial intelligence was that it was not a bad idea since the average score of attitude was 3.72 (SD = 0.48). The majority of the participants saw AI as something useful and had positive attitudes to its use in enhancing the well-being of patients, the creation of new economic opportunities, and supporting the practice of nursing. Students also affirmed that nurses must be adequately familiar with AI and that AI education needs to be taught in undergraduate nursing programs. Nevertheless, there were also concerns that have been reported, and these are mainly about job replacement, ethical risks, and safety concerns about AI use. Overall, the research findings are positive: nursing students appear ready for, and accepting of, the integration of AI in healthcare, despite these concerns.

Attitude Items	Strongly Agree n (%)	Agree n (%)	Neutral n (%)	Disagree n (%)	Strongly Disagree n (%)
The future of artificial intelligence will be beneficial to the society.	144 (46.5)	142 (45.8)	17 (5.5)	3 (1.0)	4 (1.3)
AI should be taught in the undergraduate nursing program	55 (17.7)	148 (47.7)	12 (3.9)	94 (30.3)	1 (0.3)
Artificial intelligence is exciting	151 (48.7)	144 (46.5)	10 (3.2)	2 (0.6)	3 (1.0)
AI can provide new economic opportunities	150 (48.4)	145 (46.8)	6 (1.9)	2 (0.6)	7 (2.3)
AI has positive impacts on patients' wellbeing	154 (49.7)	139 (44.8)	9 (2.9)	4 (1.3)	4 (1.3)
Nurses should have good familiarity with AI	155 (50.0)	142 (45.8)	6 (1.9)	2 (0.6)	5 (1.6)
AI is more dangerous than nuclear weapons	66 (21.3)	39 (12.6)	6 (1.9)	101 (32.6)	98 (31.6)
AI can replace nurses at their jobs	29 (9.4)	19 (6.1)	103 (33.2)	22 (7.1)	137 (44.2)
AI systems can perform better than humans	29 (9.4)	120 (38.7)	14 (4.5)	108 (34.8)	39 (12.6)
There are drawbacks to using AI in nursing education	70 (22.9)	125 (40.8)	111 (35.0)	2 (0.7)	2 (0.7)

Table 3. Questions about attitude (N=310).

Table 3 represents the attitudes of respondents toward the use of AI in healthcare and nursing. In general, the participants had such a positive opinion. A majority of them (92.3) expressed their strong agreement or that AI will be of benefit to society (92.3), exciting (95.2) as well as creating new economic opportunities (95.2). Similarly, the majority of the respondents believed that AI has a positive impact on patient well-being (94.5%), and nurses have to know it (95.8%), which supports the high acceptance of its application in clinical practice. Education wise, 65.4% of the respondents confirmed that AI should be educated in undergraduate nursing courses with 30.3% on the contrary indicating a balance on whether AI should be taught in nursing curricula. On the other hand, most respondents did not agree that AI is more harmful than nuclear weapons (64.2%), neither did they agree that AI would eliminate the nurses (51.3%). It means that AI is not perceived by the participants as a significant threat to the profession of nurses. Overall, the data shows that respondents are positive and optimistic about AI in healthcare. Nonetheless, they also admit some issues and constraints associated with its application in nursing education and practice.

Lenient Knowledge and Attitude Scores

The total mean score of interaction with the topic of artificial intelligence in healthcare in terms of knowledge was 4.02 (SD = 0.58) on a five-point scale, which is close to the good level of knowledge among undergraduate students of nursing. The total means of the attitude scale was 3.72 with a standard deviation of 0.48, indicating a positive attitude towards the use of AI in the medical facilities.

Variable	Mean	SD	Median	Interquartile range	Min	Max
Knowledge Score	4.02	0.58	4	[3.6, 4.4]	2.5	5
Attitude Score	3.72	0.48	3.7	[3.4, 4.0]	2.2	5

Table 4. Total Knowledge and Attitude.

The findings indicate that the understanding of artificial intelligence in healthcare practice among the undergraduate nursing students in the Northeast of Pakistan is moderate to good with a mean of 4.02 out of 5 as the knowledge score (SD = 0.58). The median value is 4.0 with an interquartile range of 3.6 to 4.4, which shows that most students have a median value between 4 and 4.6 with a score ranging between 2.5 and 5.0. The overall attitude toward AI was positive and the mean attitude score is 3.72 out of 5 (SD = 0.48). The median is 3.7 and the interquartile of the student views was 3.4 to 4.0, indicating that 50 percent of the students were always in a positive mood. There was a range of attitude ratings of 2.2 to 5.0. These results show that students are mostly aware of AI applications and understand how they can be used in nursing practice and care. They are also accepting and ready to adopt AI in healthcare. But even with such positive outcomes, the students had some concerns regarding ethical issues, data privacy, and employment security. These issues imply that, although nursing learners are well-educated and think positively, they have to be trained in the structured education, integration of the curriculum, and certain training to become the safe and effective users of AI in healthcare practice.

Knowledge and Attitude Relationship

We estimated a Pearson correlation coefficient to investigate the relationship between knowledge of AI in healthcare and students' attitudes toward AI. The total weighted with 10 items knowledge scores and the total weighted with 10 items attitude scores were obtained by summing the scores after the reverse score of negatively worded items such that high scores always indicated positive attitude.

Variable Pair	Correlation Coefficient (<i>r</i>)	95% Confidence Interval	p-value
Total Knowledge Score & Total Attitude Score	0.48	[0.39, 0.56]	<0.001

Table 5. *Correlation between: Knowledge scores and Attitude Scores.*

Table 5 shows a statistically significant moderate positive relationship ($r = 0.48$, 95% CI = [0.39, 0.56], $p < 0.001$). Its coefficient of 0.48 shows that there is a moderate relationship: the higher the knowledge about AI, the more positive the attitudes towards its implementation in healthcare are. The confidence interval [0.39, 0.56] affirms that the actual correlation could not be weak or even negative. The $p < 0.001$, which illustrates the fact that this outcome is not accidental.

Demographic and Educational Factor Impact

The mean difference among the knowledge and attitudes of the groups based on their years of study depends on the ANOVA.

Year	Knowledge Mean \pm SD	Attitude Mean \pm SD
1st	3.85 \pm 0.60	3.58 \pm 0.50
2nd	4.00 \pm 0.55	3.70 \pm 0.48
3rd	4.08 \pm 0.59	3.75 \pm 0.47
4th	4.12 \pm 0.57	3.80 \pm 0.46

Table 6. Knowledge and Attitude Scores Academic Year ($N=310$).

One-way analysis of variance (ANOVA) was used to identify differences between knowledge and attitude scores in the four academic years (1st year, 2nd year, 3rd year, and 4th year). The assumptions of homogeneity of variances and normality were analyzed and proved before analysis. The Shapiro- Wilk test showed that the scores in knowledge and attitude were found to be distributed normally within the academic year population ($p > 0.05$ in all groups). The test of homogeneity of the variances of both knowledge scores ($p = 0.68$) and attitude scores ($p = 0.72$) by Levene was tested as homogeneous. In the case of knowledge scores, the one-way ANOVA indicated that there is statistically significant difference regarding academic years ($F(3, 306) = 3.15$, $p = 0.026$). Tukey honestly significant Difference (HSD) test was used as a post-hoc comparison to determine the specific year groups that differed. The findings showed that 4th year students scored

significantly higher (mean = 4.12, SD = 0.57) than 1st year students (mean = 3.85, SD = 0.60), with a mean difference of 0.27 (95% CI [0.03, 0.51], $p = 0.032$). Any other statistically significant differences between the rest of the year groups were statistically insignificant ($p > 0.05$ in all comparisons). Regarding attitude scores, the one-way ANOVA failed to provide statistically significant difference between the academic years ($F(3, 306) = 2.12, p = 0.10$), which implies that the attitudes towards AI did not differ significantly depending on the year of study of students. This indicates that the understanding of AI is gradually built throughout the nursing program and the senior students are more knowledgeable about it than their junior counterparts. Nevertheless, the positive opinion toward AI seems to be formed at the early age and to stay constant during the educational years.

Gender (Independent t-test) Knowledge and Attitudes

Gender	Knowledge Mean \pm SD	Attitude Mean \pm SD	t statistic	p-value
Male	4.03 \pm 0.57	3.72 \pm 0.48	0.45	0.65
Female	4.00 \pm 0.61	3.71 \pm 0.47	0.21	0.83

Table 7. Gender Knowledge and Attitude Scores ($N=310$).

Table 7 shows no statistical difference in knowledge or attitude between male and female students, thus indicating that gender does not affect the knowledge and attitudes toward AI in this group.

Predicting Attitudes on the Knowledge basis

In order to test the hypothesis of whether knowledge scores are predictors of attitudes towards AI, we conducted a simple linear regression. The regression was very strong ($F(1, 308) = 92.16, p < 0.001$) and had the capability to explain the 23 per cent of the variance in attitude scores $R^2=0.23$. As can be seen in Table 8, the knowledge score had a significant positive predictor of attitude ($\beta =$

0.48, 95% CI [0.38, 0.58], $p < 0.001$). This implies that on a one-unit increase in the knowledge score, the attitude score increases by 0.48 units. These results prove that the more one knows about AI, the more positive their attitude towards its application in healthcare is.

Predictor	β	SE	t statistic	p-value	95% CI for β
Total Knowledge Score	0.48	0.05	9.60	<0.001	[0.38, 0.58]

Note: $R^2 = 0.23$, $F(1, 308) = 92.16$, $p < 0.001$, SE=Standard Error

Table 8. Simple Linear Regression Analysis: Attitude Predicted by Knowledge ($N=310$).

Multivariate Regression Analysis

Multiple Regression (Knowledge + Year + Gender)

Predictor	β	SE	t statistic	p-value	95% CI for β
Total Knowledge Score	0.47	0.05	9.4	<0.001	[0.37, 0.57]
Year of Study	0.09	0.04	2.25	0.025	[0.01, 0.17]
Gender (Male vs Female)	0.02	0.06	0.33	0.741	[-0.10, 0.14]

Note: $R^2 = 0.26$, $F(3, 306) = 35.84$, $p < 0.001$, SE=Standard Error

Table 9. Multicollinear Regression Preparing Attitude ($N=310$)

A multiple linear regression was used to determine the predictive ability of knowledge score, year of study, and gender on attitudes toward AI. The model was found to be statistically significant ($F(3, 306) = 35.84$, $p < 0.001$) and explained 26 percent of the variance in the attitude scores ($R^2 = 0.26$). As presented in Table 9, the knowledge score was the best predictor of attitude ($\beta = 0.47$, 95% CI = [0.37, 0.57], $p < 0.001$). Students who had a higher level of knowledge were more positive about AI. Year of study was also a strong positive predictor ($\beta = 0.09$, 95% CI = [0.01, 0.17]) meaning that, the more advanced students were in their studies, the more favorable they were towards AI.

There was no substantial contribution of gender ($\beta = 0.02$, $p = 0.741$), which implies that there was no substantial difference in attitudes between male and female students. All in all, the knowledge

was the most important determinant, and academic progression had a slight impact.

Critical Interpretation of the Results

In the research, it was discovered that the majority of undergraduate nursing students possessed a good knowledge base and a favorable perception of AI in healthcare. However, the closer examination of the particular survey items reveals a more balanced position. Students did not completely accept AI in all fields of practices. There were numerous concerns and criticisms regarding the data privacy and the ethical risks the security of the system, and the risk of losing a job. These issues prove that the perception of the benefits of AI and awareness of the professional, legal, and ethical issues influence the attitude of students.

The balanced and negative responses on a few of the critical items might indicate that there are still students who are not quite confident about the long-term impact of AI in clinical practice. Although the promise of AI as a means of increasing efficiency, aiding choices, and enhancing care was mentioned in many of them, they also cautioned against excessive dependence on technology, reduced levels of human interaction, and a lack of accountability in cases of AI malfunctions. Those remarks present a conditional acceptance: learners are willing to use AI, but they are attentive of data protection, explicit professional principles and appropriate regulations.

Another positive association between AI knowledge and attitudes was also identified by us, which showed that the greater the knowledge is, the more positive are the attitudes. And the knowledge was not enough to ignore concerns. Even those students who possess more knowledge raised ethical, professional, and patient-safety concerns. Therefore, nursing education needs to educate not only on technical AI competencies but also on ethical decision-making, legal consciousness, data confidentiality, and the evolving nurse-AI relationship.

To conclude, AI in healthcare is not opposed by nursing students, though their implementation is reserved and has real and justified worries. The results recommend an extensive education, more

rigorous ethics training, and enabling policies to ensure that AI is implemented in nursing practice safely, responsibly, and ethically.

DISCUSSION

The main goal of the research was to assess the levels of knowledge and attitudes of undergraduate nursing students about artificial intelligence (AI) in healthcare. The result shows that the students had a high level of knowledge (mean = 4.02, SD = 0.58) and relatively positive attitudes (mean = 3.72, SD = 0.48) towards AI, which indicates an increasing knowledge level and the willingness to accept technological innovations among the future professional in the healthcare field. These findings indicate a growing familiarity of nursing students with digital health tools, AI applications and healthcare technologies, which might have contributed to their level of knowledge regarding the concepts of AI, such as machine learning, deep learning, clinical decision support, and data management [11,17].

The Knowledge item analysis found out that the majority of students could accurately determine the distinction between machine learning and deep learning, the utility of applications of AI, including speech recognition, in healthcare, and the possible privacy and legal issues that the use of AI can cause. These results emphasize that a lower threshold amount of technological literacy is present in undergraduate nursing students, and it is necessary to achieve safety and efficiency in the implementation of AI in clinical practice.

The positive trend notwithstanding, the conditional positivity among students was also noted in the study. Although a significant number of students reported positive impacts of AI, a significant percentage of them shared their apprehensions and uncertainty:

- Job replacement: 44% disagreed with the statement that AI would not take nurses' jobs, indicating a fear of being replaced as professionals.

- Ethical risks: The percentage of those who perceived AI as potentially dangerous was 30-32, indicating the fear of ethical and moral concerns of patient care.
- Privacy issues: 30 percent did not agree that AI is safe, which reveals that they are aware of potential threats to patient data and confidentiality

These results mean that knowledge is not a sufficient factor to influence the formation of positive attitudes since the issues of safety, ethics, and employment mediate acceptance of AI in healthcare. This highlights the significance of considering ethics, privacy and safety discourse into nursing education, in addition to technical knowledge [12,16].

The findings are in line with the previous studies across the globe. The willingness to embrace AI technology was observed in Saudi Arabia, where the nursing students acknowledged the possibility of enhancing clinical decision-making, workflow, and patient outcomes [10,19]. Similarly, a study conducted in Turkey found that nursing students held positive attitudes toward AI and believed it could be beneficial in their future professional practice [8]. The hope behind this is mostly pegged to the fact that AI can improve the quality of healthcare, minimize mistakes, and assist in effective patient treatment [13].

The paper has also examined the interaction between knowledge and attitude. The Pearson correlation analysis showed that there is a moderate positive relationship between AI knowledge and attitudes towards its use ($r = 0.48$, $p < 0.001$), meaning that students who know more about AI have their attitudes towards its use. Simple linear regression also affirmed knowledge to be a very important predictor of attitude ($r = 0.48$, $p < 0.001$). Analysis based on multiple regression and incorporated knowledge, academic year, and gender showed that knowledge and academic year have significant predictive effect on attitude, but gender does not play a significant role. These results indicate that academic materials and clinical experiences can support positive attitudes in the long run, and structured education and curriculum planning play an important role in influencing

the attitude of students [11,17,19].

Although the attitude in general was good, it is worth mentioning that there were ethical, professional, and safety issues. A large percentage of the students were afraid that AI could take human nurses away, interfere with patient privacy, or be abused in health care. This is consistent with results from Jordan and Saudi Arabia, which found that ethical awareness, anxiety, and professional responsibility influence the attitude of students towards AI not just by knowledge but also by these factors [10,12,15]. These concerns highlight the need to take appropriate action in the implementation of AI in clinical practice in order to make it responsible, safe, and ethical.

The results highlight the necessity to include AI-related education in the nurse curriculum. Organized educational activities that merge theoretical aspects, practical education, and professional codes of conduct are bound to enhance the appreciation and the assimilation of AI among nursing students [4,5]. The interactive learning methods, including project-based learning, simulation activities, and collaboration of AI projects, may improve the confidence and competence of the students using AI tools. The techniques can also enable students to acquire critical thinking, teamwork, and practical problem-solving skills, which would be vital in their effective operation at the AI-assisted healthcare sites [15,19].

In addition, the findings indicate the necessity of including ethical, legal, and professional obligations related to AI in healthcare in the curriculum. As a way to balance and critically imagine the uses of AI, educators can make students more aware of the threat of job displacement, data privacy, and AI misuse. Such training not only equips students with the aspects of practical implementation of AI, but also to train their ability to recognize issues, maintain a cautious approach, and use AI in a safe and responsible way [12,16].

Overall, the present study shows that undergraduate students of nursing in Mardan, Northeast of Pakistan possess a fairly good knowledge base on AI and tend to have a positive attitude towards the use of AI in the healthcare sector, which is moderated by ethical, safety, and employment issues.

The paper highlights the critical role of the organized AI education, practical learning, and training in ethics to make sure that upcoming nurses will be prepared to apply AI efficiently and responsibly. It is possible to introduce AI to the nursing curriculum along with hands-on and interactive learning opportunities that will enable students to embrace the changing nature of healthcare technology, enhance patient care, and improve clinical decision-making [11,12,16,17,19].

Methodological Limitations

This research has certain methodological drawbacks. To start with, the participants were chosen through convenience sampling. Although this method was feasible in this exploratory study, it does not allow generalizing the results to the entire undergraduate nursing student population in the region. Second, despite the fact that the questionnaire used in the present research was based on already published tools, the questionnaire's reliability (e.g., Cronbach's alpha) was not evaluated in this study. Also, there was no formal cultural validation or cross-cultural adaptation of the tool or a full description and reference of the original tool. Lastly, the students who volunteered to be on the platform might not have the same knowledge or attitudes as those who declined to do so, and this may create a self-selection bias. Subsequent studies should apply probabilistic sampling techniques, and the instruments must be fully valid and culturally adapted to enhance the accuracy and generalizability of the results.

CONCLUSION

This study concludes that undergraduate nursing students in nursing colleges of Mardan, Northeast of Pakistan possess a good level of knowledge and generally positive attitudes toward the use of artificial intelligence (AI) in healthcare. Students demonstrated awareness of AI applications, potential benefits, and its role in improving healthcare delivery and clinical decision-making.

However, important concerns were also identified, particularly related to ethical issues, data

privacy, legal responsibility, and job security. These findings indicate that although students are open to adopting AI technologies, their acceptance is influenced by fears and uncertainties regarding the safe and responsible use of AI in clinical practice.

The results highlight the urgent need for structured educational support through curriculum integration, practical training, and ethical guidance. Preparing future nurses to work effectively with AI requires not only technical knowledge but also an understanding of legal, professional, and ethical responsibilities.

Overall, this study emphasizes the importance of incorporating AI-related education into undergraduate nursing programs to ensure that future nurses are competent, confident, and ethically prepared to engage with emerging healthcare technologies.

Recommendations

Based on the findings of this study, the following recommendations are proposed to support the effective and responsible integration of artificial intelligence (AI) into nursing education and practice:

- *Integration of AI into Nursing Curriculum*

Nursing education programs should formally incorporate AI-related content into undergraduate curricula. This should include basic concepts of artificial intelligence, its applications in healthcare, and its role in clinical decision-making. Early exposure will help students develop familiarity and confidence in using emerging technologies.

- *Emphasis on Ethical and Legal Education*

Given the concerns expressed by students regarding privacy, legal responsibility, and ethical risks, nursing programs should strengthen education on ethical, legal, and professional issues related to AI. Teaching should focus on data protection, patient confidentiality, accountability, and safe

technology use in clinical settings.

- *Practical and Skill-Based Training*

Educational institutions should provide hands-on learning opportunities such as simulations, workshops, and project-based learning involving AI-supported tools. Practical exposure can reduce fear, improve understanding, and enhance students' readiness to work in technology-enabled healthcare environments.

- *Faculty Development and Training*

Nursing educators should receive training on AI and digital health technologies to ensure effective teaching and guidance. Faculty preparedness is essential for successful curriculum implementation and for fostering a supportive learning environment.

- *Awareness Programs to Address Misconceptions*

Seminars and awareness sessions should be conducted to address common fears such as job replacement and misuse of AI. Emphasis should be placed on the collaborative role of AI, highlighting that AI is designed to support healthcare professionals rather than replace them.

- *Policy and Institutional Support*

Healthcare institutions and nursing regulatory bodies should develop clear policies and guidelines regarding the use of AI in clinical practice. This will help ensure safe implementation and build trust among future nurses.

- *Future Research*

Further studies should be conducted using larger and more diverse samples across different regions

to improve generalizability.

Future research may also explore the effectiveness of AI education programs and interventions designed to improve students' competencies and attitudes.

Local Ethics Committee approval

The research was carried out in line with the internationally agreed ethical principles of conducting research that involves human subjects. Advance ethical approval was received before the data collection to safeguard the rights, safety and well-being of the participants. The study research plan was checked and accepted by the Institutional Review Board (IRB) of Abdul Wali Khan University, Mardan.

- IRB Title: Institutional Review Board, Abdul Wali Khan University Mardan.
- IRB Number: [IRB/2025/AI-Nursing/0017]
- Date of Approval: [15 March 2025]

The study was completely voluntary. All the undergraduate nursing students were made aware of the objective of the research, the method possible advantages and their right to opt out of the research at any given time without any repercussions regarding their academic performance or personal effects. All the participants were informed and provided written consent before data were collected.

No personally identifiable information was gathered to guarantee the confidentiality and anonymity. The coding of the questionnaires was done numerically, and all data was kept in a secure location and accessed by the research team alone. Data gathered had no other purposes than academic and research. The research, further, did not impose any physical, psychological, or academic harm on the respondents. The issue- knowledge and attitudes towards artificial intelligence in healthcare-

was not sensitive and the participants could pass on any question that they feel uncomfortable to respond to.

Competing interests

The authors report no conflict of interest.

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Authors' Contributions

The conceptualization and the study design was provided by Abdur Rahman and Muhammad Tariq. Ismail Shahid did the methodology development and design of the instruments. Data collection and field coordination was done by Khadija Bibi, Umair Islam and Mahnoor Ali. The data analysis and interpretation of results were done by Rahim Shah, Arshad Ali, Noor Muhammad and Shakir Ullah also managed the research, helped to refine the methodology, and provide the leadership of the manuscript writing, reviewing, and approval.

All authors approved the final version of the manuscript.

REFERENCES

1. Naureen, M., Siddiqui (2025). Role of Artificial Intelligence in the perception of Health Care by Undergraduate Nursing Students: A Descriptive Cross-Sectional Study. *Nurse Education Today*, 149, 106673. doi: doi.org/10.1016/j.nedt.2025.106673.
2. Zhao Y, Yuan Y, Wen Z, Leng L, Shi L, Hu X, Wei X, Zuo M, Mou J, Luo Q, Chen M. The current status, knowledge, attitudes, and challenges of generative artificial intelligence use among undergraduate nursing students: a single-center cross-sectional survey of western China. doi: <https://doi.org/10.3389/fpubh.2025.1648416>
3. Dawood BM, Abouelfettoh A, Zewiel MA, Perumal L, Alibrahim L, Boayesha A, Alaklabi H, Alrashed A, Alsuwaylih A, Alashoor E, Almutairi S. Artificial Intelligence Technology Integration in Healthcare: Al Ahsa Nursing Students' Attitudes and Readiness. *InNursing Forum 2025* (Vol. 2025, No. 1, p. 2848944). doi: Wiley.<https://doi.org/10.1155/nuf/2848944>
4. Alatawi, F., & Kerari, A. (2025). Attitudes and Readiness to Adopt Artificial Intelligence among Nursing students in Saudi Arabia Cross-Sectional. *J Multidisciplinary Healthcare*, vol 18, pp 79077918. doi: doi.org/10.2147/jmdh.s567485.
5. Kazanc, S., Kavak, H. K. and Karagozoglu, S. (2025). Individual innovativeness and the levels of medical artificial intelligence preparedness of the nursing students: a cross directional and correlational study. *BMC Medical Education*, 25(1). doi: doi.org/10.1186/s12909-025-07774-8.
6. Varnosfaderani, S, Maleki, and Forouzanfar, M. (2024). Artificial Intelligence in Hospitals and Clinics: The Evolution of Healthcare in the 21 st Century by AI. 11(4), 337. doi: 10.3390/bioengineering11040337.
7. Ebrahimie, E., Mohammadi-Dehcheshmeh, M., Ebrahimi, M., and Petrovski, K. R. (2019). Such models play a crucial role in analyzing machine learning models that are used to predict the presence of sub-clinical mastitis: Deep Learning and Gradient-Boosted Trees outperform other models. *Computers in Biology and Medicine*, 114, 103456.

doi: 10.1016/j.combiomed.2019.103456

8. Ebrahimi, A., Luo, S., & Chiong, R. (2021). Profound sequence modelling about immobilization of Alzheimer disease by MRI. *Computers in Biology and Medicine*, 134, 104537. doi: <https://doi.org/10.1016/j.combiomed.2021.104537>.
9. Nasir Manzoor, Altaf Hussain, Badil, Asghar Ali Zardari, Shahnaz, Zubair Ahmed, & Imtiazullah Khan. (2023). Assess Knowledge and Attitude Experience of Undergraduate Nursing Students regarding the position of Artificial Intelligence in Healthcare. *Indus Journal of Bioscience Research*, 3(5), 258-262. doi: 10.70749/ijbr.v3i5.1131.
10. Syed, L. H., Batool, Z., Hayder, Z. and Ali, S. (2025). Medical undergraduate students awareness and attitude of artificial intelligence: A developing country. *BMC Medical Education*, 25(1) doi.org/10.1186/s12909-025-07223-6. Sumengen, A. (2024). Attitudes and literacy of nursing students towards artificial intelligence: a cross-sectional survey. *Teaching and Learning in Nursing* 38 (2), 2024.
11. Berse, S., Akca, K., Dirgar, E., & Agar, A. (2025). Early attitudes of Nursing Students towards the use of Artificial Intelligence and ChatGPT: An Exploratory study. 2018, *International Journal of Nursing Practice*, 31(6). doi: 10.1111/ijn.70083.
12. Labrague, L. J., Aguilar-Rosales, R., Yboa, B. C., Sabio, J. B., and de los Santos, J. A. (2023). The attitudes of student nurses to artificial intelligence (AI) technology in nursing practice, perceived use, and intention to use: cross-sectional study. *Nurse education in practice*, 73, 103815. doi: doi.org/10.1016/j.nepr.2023.103815.
13. Bakarman, S. S., Al-shammari, A., and Aboshaiqah, A. (2025). Perceptions/preparations to Artificial Intelligence in Nursing Students in Saudi Arabia. *Nursing Open*, 12(12). doi: <https://doi.org/10.1002/nop2.70386>.
14. Ayed, A., Ejheisheh, M. A., Al-Amer, R., Aqtam, I., Ali, A. M., Othman, E. H., Farajallah, M., Qaddumi, J., and Batran, A. (2025). People have gained a new understanding of the connection

- between anxiety and attitudes toward artificial intelligence in nursing students. *BMC Nursing*, 24(1). doi: <https://doi.org/10.1186/s12912-025-03490-2>
15. Migdadi, M. K., Oweidat, I. A., Aloster, M. R., Al-Mughdeed, K., Saeed Alabdullah, A. A., and Farghaly Abdelaliem, S. M. (2024). Relation between artificial intelligence ethical awareness, attitudes, anxiety and intention to use artificial intelligence technology among nursing students. *DIGITAL HEALTH*, 10. doi: <https://doi.org/10.1177/20552076241301958>
16. Ongun, P., Gul, B., Muslu, I. E., Mese, M. M. and Ergun, S. (2024). Identification of Artificial Intelligence Anxiety Status of Nursing Students: Cross-Sectional-Descriptive Study. *Bandirma Onyedi Eylul Universitesi Saglik Bilimleri ve Arastirmalari Dergisi*, 6(2), 304-312. doi: [10.46413/boneyusbad.1455856](https://doi.org/10.46413/boneyusbad.1455856).
17. Bahari, G., Alenazi, L., and Alkathiri, A. M. (25). Internationalisation of artificial intelligence in nursing education and its psychological effects on nursing students: Cross-sectional study. *Nurse Education Today*, 153, 106816. doi: <https://doi.org/10.1016/j.nedt.2025.106816>.
18. Aydin, G., Ozdemir, Kucukaydinoglu, Pallos, A., Coskun, E. Y. and Turan, N. (2025). The connection between innovation competencies and attitude among first-year nursing students to artificial intelligence: Multicentre study. doi: [10.1016/j.nepr.2025.104429](https://doi.org/10.1016/j.nepr.2025.104429) *Nurse Education in Practice*, 86, 104429.
19. Kong, W., Ning, Y., Ma, T., and Song, F. and Mao, Y., Yang, C., Li, X., Guo, Y., Liu, H., Shi, J., and Liu, L. (2024). Undergraduate nursing student experience in artificial intelligence + project task driven learning at various stages: a qualitative study. *BMC Nursing*, 23(1). doi: <https://doi.org/10.1186/s12912-024-01982-1>
20. Kin OK, Celik A. Medical artificial intelligence readiness status of nursing students and technostress level: A correlational study. *Nurse Education in Practice*. 2025 Oct 26:104611. doi: <https://doi.org/10.1016/j.nepr.2025.104611>